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EFFECTS OF SPINDLE-PICKER CONVEYING AND GIN PROCESSING ON COTTON QUALITY AND SEED DAMAGE

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EFFECTS OF SPINDLE-PICKER CONVEYING AND GIN PROCESSING ON COTTON QUALITY AND SEED DAMAGE[1]

By Gary L. Barker, Charles S. Shaw, and Kirk E. Luckett [2]

Trash and moisture in mechanically harvested seed cotton are the most important factors that influence lint quality. Although cotton cleaning and drying processes improve classer's grade, they tend to affect other lint qualities adversely.

Mechanical damage of seed also affects lint quality as fragments from the seedcoat of the cracked seed are difficult to remove from the lint. Seed damage itself is a major concern to seed companies when harvesting seed stock. The impact forces that occur in the conveying system of a cottonpicker are considered to be the primary cause of cracked seed during mechanical harvesting. The objectives of this study were to determine the effects of the seed cotton harvesting and conveying system on (1) fiber and seed quality, and (2) cleaning and ginning requirements.

LITERATURE REVIEW

Williamson, Shaw, Looney, and Shanklin [3] compared mechanical harvesters equipped with 9/16-inch tapered barbed, 1/4-inch straight barbed, and 3/16-inch straight smooth picker spindles with hand picking. They found that the handpicked cotton was slightly shorter in length, contained less foreign matter, and was lower in strength and micronaire than machine-picked cotton. They found no important differences among machine types.

Considerable research has been done on the effects of mechanical damage on cottonseed quality. Helmer [4] found that the percentage of seedling emergence for acid-delinted seed was significantly reduced as the degree of mechanical damage increased. He also found that mechanical damage reduces the storability of cottonseed. Douglas, Brooks, and Perry[5] showed that smaller seeded varieties and that seed produced with 10,000 plants per acre were less severely damaged by the mechanical harvester than when the stands were thicker. They found that considerable damage to the cottonseed occurred when the seed cotton passed directly through the fan of a mechanical harvester. This damage is reflected in poor germination and vigor.

The causes and effects of mechanical damage to cottonseed have been studied thoroughly. Kirk and McLeod [6] determined that a static load of 0.70 inch-pound will generally rupture cottonseed and that a velocity of 5,000 feet per minute

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[1] Cooperative investigation of the Agricultural Research Service, U. S. Department of Agriculture, and the Delta Branch of the Mississippi Agricultural and Forestry Experiment Station, Stoneville, Mississippi.

[2] Barker and Luckett, agricultural engineers, and Shaw, research cotton technologist, Southern Region, Agricultural Research Service, U. S. Department of Agriculture. Barker is located at Mississippi State, Miss., and Shaw and Luckett, at Stoneville, Miss.

[3] Williamson, E. Buford, Shaw, Charles S., and Looney, Zolon M, Comparative Effects of Mechanical Picking Spindles and Hand Picking on Cotton Quality and Spinning Performance in Mississippi, 1960-63. U. S. Dept. Agr. Mktg. Res. Rpt. 730, 16 pp. 1966.

[4] Helmer, J. D. Effect of Mechanical Damage on the Overall Quality and Emergence of Cottonseed. Beltwide Cotton Prod. Res. Conf. Proc. 1967. 138 Dallas, Tex. 1967.

[5] Douglas, A. G., Brooks, O. L., and Perry, C. E. Influence of Mechanical Harvester Damage on Cottonseed Germination and Seedling Vigor. Beltwide Cotton Prod. Res. Conf. Proc. (1967):129-134. Dallas, Tex. 1967.

[6] Kirk, J. W ., and McLeod, H. E. Cottonseed Rupture from Static Energy and Impact Velocity. Amer. Soc. Agr. Engin. Trans. 10 (2):217-219. 1967.

(f.p.m.) will rupture 7.44 percent of the cottonseed compared with 50 percent at a velocity of 7,700 f.p.m. Clark, Welch, and Anderson[7] in a similar study concluded that the optimum cottonseed moisture content for minimum reduction in germination and seed crackage was 8 to 10 percent wet basis and that the maximum seed impact velocity to assure 80 percent germination and low seedcoat crackage was 5,000 f.p.m.

Garner[8] reported that the picker fan speed exerts the greatest influence on percentage of cracked seedcoats. Garner also reported that doffers and the basket grates have little influence on the percentage of cracked seeds and that simply reducing the fan wheel speed from 2,330 to 1,800 revolutions per minute decreased the percentage of visible cracked seeds by 50 percent.

Moore and Shaw[9] show that higher air velocities contribute toward cottonseed damage in cotton gins and that within the gin, the gin stand itself does most of the damage to the seed.

EXPERIMENTAL PROCEDURE

Stoneville 7A cotton was mechanically harvested with a two-row tapered-spindle picker in 1967, 1968, and 1969 at Stoneville, Mississippi. The conveying system in this model picker passed the seed cotton through the fan. In 1967, cotton was collected from one picking unit immediately after it was doffed from the spindles while cotton from the other unit was pneumatically conveyed to the picker basket in the normal manner. A seed cotton hopper box was constructed and attached to one unit (fig.1) to collect the "nonconveyed" samples. The picker was modified in 1968 and 1969 to collect the "conveyed" sample from the front drum of the right picking unit. This change improved sampling technique by eliminating the cotton picked with the rear drum from all the samples.

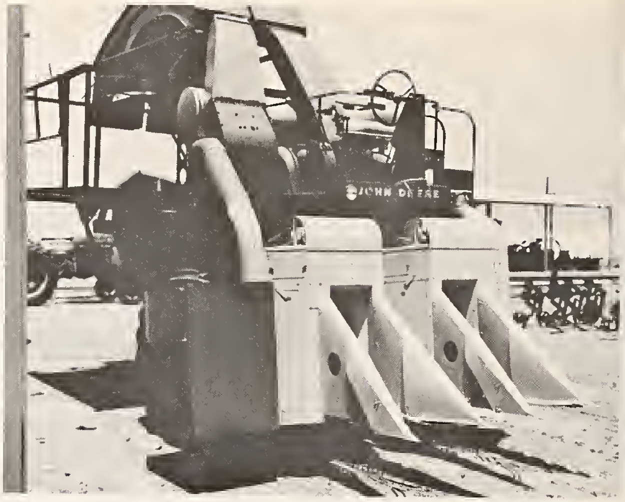

Figure 1. Seed cotton hopper box mounted on one unit of a two-row cottonpicker for collecting seed cotton between the doffing and conveying operations, Stoneville, Miss.

The cotton was processed through the microgin plant at the U. S. Cotton Ginning Research Laboratory in Stoneville. Representative lots were used and were subjected to the various combinations of (1) no drying, (2) drying, (3) no lint cleaning, and (4) two lint cleanings. For each combination, the following normal overhead cleaning arrangement was used: 6-cylinder cleaner, stick remover, 6-cylinder cleaner, and feeder cleaner.

Sufficient samples were extracted from each lot to indicate the effects of (1) conveying on seed damage and wagon-sample trash content; (2) conveying, drying, and ginning on seed damage and feeder-sample trash content; and (3) conveying, drying, and lint cleaning on fiber and yarn properties as determined by miniature spinning tests.

RESULTS OF THE STUDY

No difference was noted in wagon-sample moisture content between the conveyed and nonconveyed treatments in 1967 and 1969. However, in 1968 the conveyed treatments contained significantly more moisture than the nonconveyed treatments (table 1). As expected, drying at the gin reduced the moisture content of the lint.

The pneumatic conveying system of the mechanical cotton picker, which subjected the seed cotton to impact from the conveying fan blades and the basket grates, had a highly significant effect on the visible damage of the cottonseed (table 2). Seed damage differed substantially between the years; however, the trends were consistent. The 3-year average shows the conveyed seed to have almost twice as many damaged seed as the non-conveyed, 11 and 6 percent, respectively (table 2). Garner reported similar results in his air velocity studies.[10]

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[7] Clark, R. L., Welch, G. B., and Anderson, J. H. Effect of High-Velocity Impact on Germination and Crackage of Cottonseed. American Soc. Agr. Engin. Trans. 12 (6):748-751. 1969.

[8] Garner, T. H. Cottonseed Germination and Quality as Affected by Harvesting Operations. Report of the Agricultural Engineering Department, South Carolina Agricultural Experiment Station, Clemson, S. C. (Unpublished.)

[9] Moore, Vernon, Vernon P. and Shaw, Charles S. Mechanical Damage to Cottonseed. The Cotton Gin and Oil Mill Press, Vol. 68, No. 5, March 11, 1967.

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[10] Cited in footnote 8, p. 2.

TABLE 1. Seed cotton, seed, and lint moisture pertaining to the conveying study, 1967-69

Year and picking and ginning treatment	Moisture content: Wagon sample	Moisture content: Feeder sample	Moisture content: Seed	Moisture content: Lint
1967	*Percent*	*Percent*	*Percent*	*Percent*
Conveyed and ginned:				
Undried	9.2	9.5	9.4	6.6
Dried	9.3	7.9	9.9	4.9
Non-conveyed and ginned:				
Undried	9.1	8.7	9.6	6.2
Dried	9.5	8.0	9.5	5.1
1968				
Conveyed and ginned:				
Undried	12.9	10.8	12.7	7.0
Dried	12.6	10.8	12.7	7.0
Non-conveyed and ginned:				
Undried	10.8	9.5	11.6	6.9
Dried	9.7	8.2	10.3	5.6
1969				
Conveyed and ginned:				
Undried	11.8	9.6	10.6	8.8
Dried	10.9	9.3	9.8	8.0
Non-conveyed and ginned:				
Undried	9.6	9.5	9.6	8.0
Dried	12.8	10.2	10.4	8.6

TABLE 2. Effects of a picker-conveying system on damage of wagon sample and ginned cottonseed, Stoneville, Miss., 1967-69

Picker treatment	1967	1968	1969	3-year average (weighted)
	Percent	*Percent*	*Percent*	*Percent*
Wagon-sample cottonseed:				
Conveyed	17	12	4	11
Nonconveyed	10	6	2	6
Ginned cottonseed:				
Conveyed	28	12	12	17
Nonconveyed	22	10	10	14

Ginning increased seed damage from an average of 8.5 percent before ginning to 15.6 percent after ginning. The effect of picker conveying was still evident after ginning (table 2). Also, in these particular experiments, drying significantly reduced seed damage in the gin (table 3). There was no significant interaction for the seed damage data among picking treatments, ginning treatments, or drying treatments.

Significantly more hulls, sticks and stems, leaf, motes, and total foreign matter content were found in the cotton conveyed through the picker-conveying system than in the nonconveyed system (table 4). Almost all the difference in hulls content occurred in 1967 and is probably due to the sampling technique used that year. There was no difference in hulls content between the conveyed and nonconveyed treatments for 1968 and 1969. However, the other foreign matter components (sticks and stems, leaf, and notes) showed the same general trends all 3 years, indicating that the sampling technique used in 1967 had little influence on the overall average results pertaining to these components.

Neither picker conveying nor drying in the gin significantly affected the amount of hulls or sticks and stems found in the seed cotton at the feeder apron. A significant interaction occurred between picker conveying and drying in the gin for the leaf and motes content at the feeder apron (table 5). The samples conveyed through the picker-conveying system had slightly more total foreign matter content than the non-conveyed samples, 2.0 and 1.8, respectively. The fan in the picker-conveyor either draws in more foreign matter with the harvested cotton or beats and imbeds it into the fiber so that it is harder to remove.

TABLE 3. Relationship of drying at the gin to damage of ginned cottonseed, Stoneville, Miss., 1967-69 [1]

Ginning treatment	Cottonseed Damage			3-Year average
	1967	1968	1969	
	Percent	*Percent*	*Percent*	*Percent*
Undried	28.8	11.9	11.4	17.3
Dried	21.3	10.6	10.5	14.1

[1] Average of conveyed and nonconveyed.

TABLE 4. Effects of the picker-conveying system on foreign matter content in the wagon sample, Stoneville, Miss., 3-year average, 1967

Foreign matter component	Picker treatment	
	Conveyed	Nonconveyed
	Percent	*Percent*
Hulls	1.8	1.5
Sticks and stems	.6	.4
Grass	(1)	.1
Leaf	1.8	1.7
Pin trash	.1	.1
Motes	.8	.6
Total	5.1	4.4

[1] Trace

TABLE 5. The interaction of the picker-conveyor system and drying at the gin on foreign matter content at the feeder apron

Picking and Ginning Treatment	Types of foreign matter				
	Hulls	Sticks & Stems	Leaf	Motes	Total Foreign Matter
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Conveyed:					
Undried	0.3	0.3	1.1	0.4	2.1
Dried	0.3	0.3	1.0	0.3	1.9
Nonconveyed					
Undried	0.3	0.3	0.9	0.3	1.8
Dried	0.2	0.3	1.0	0.3	1.8

The use of two lint cleaners significantly improved classer's grade index, reduced staple length, and reduced the foreign matter content of the lint in this study (table 6). The picker-conveyor system and drying in the gin had no significant effect on classer's grade or staple length. However, the picker-conveyor system significantly increased the amount of foreign matter contained in the lint, 3.88 percent compared with 3.70 percent for the nonconveyed treatment. Drying in the gin significantly reduced the foreign matter content of the lint, 3.70 percent compared with 3.88 percent for the undried samples. No significant interaction was evident between treatments for the lint foreign matter content.

TABLE 6. Effects of lint cleaning on classer's grade, staple length, and foreign matter content of the lint.

Treatment	Classer's grade[1]	Staple length	Lint foreign matter content
	Index	*32ds inch*	*Percent*
No lint cleaner	88.3	34.6	5.02
2 lint cleaners	91.6	34.4	2.56

[1] 94 = SLM; 90 = LM, plus; and 85 = LM.

The use of two lint cleaners in the gin tended to reduce fibrograph length but had no effect on the uniformity index (table 7). Drying in the gin also tended to reduce very slightly the fibrograph 2.5-percent span length, 1.10 inches compared with 1.11 inches for the undried treatments. Drying had no effect on the 50-percent span length. Drying was the only factor that significantly affected yarn strength. The 22s (27.0 Tex) yarn strength for the dried cotton averaged 106.5 pounds compared with 108.1 pounds for the undried cotton. The coefficient of variation for the yarn strength data was 3.9 percent.

TABLE 7. Effects of lint cleaning on fibrograph 50 percent and 2.5-percent span length and uniformity ratio

Lint-cleaning treatment	Fiber Data		
	Span length		Uniformity ratio
	50 percent	2.5 percent	
	Inches	*Inches*	*Index*
No lint cleaner	0.48	1.12	42
2 lint cleaners	.46	1.10	42

Micronaire fiber fineness measures were not significantly affected by any of the treatments in this study. However, the cotton harvested in 1967 had a very low micronaire reading, 2.8, compared with 4.2 for 1968 and 4.8 for 1969. The cotton harvested in 1967 was harvested late in the year. A study of the other fiber data for 1967 failed to indicate immaturity for this year and offers no explanation for the low micronaire measurements on these 1967 samples.

SUMMARY AND CONCLUSIONS

The broad objective of this project was to study the interrelated effects of seed cotton spindle-harvesting and handling systems on the response of the cotton to cleaning and ginning. Cotton collected after traveling through the picker-conveying system was compared with cotton collected immediately after doffing. Half this cotton was subjected to drying in the gin, and half left undried. The cotton was divided again and half of it subjected to two lint cleaners. The other half had no lint cleaning.

The pneumatic-conveying system on a cotton picker that subjects the seed cotton to impact from the conveying fan blades as well as the picker basket grates almost doubles the amount of visible damage to cottonseed. The ginning machinery added about 7 percent more damaged seed. The fan of the picker-conveyor system evidently draws in more foreign matter with the harvested cotton. Drying the cotton increased the efficiency of foreign matter removal in lint cleaning.

Two lint cleaners reduced the foreign matter content of the lint by approximately 50 percent. The lint cleaner improved classer's grade but slightly shortened fiber length and reduced yarn strength.

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